

바닥판 검토

1. 바닥판(중앙부_DB18)

▷ 검토 조건

$$\begin{aligned} f_{ck} &= 24.0 \text{ MPa} & f_y &= 300.0 \text{ MPa} & \lambda &= 1.00 \\ \beta_1 &= 0.85 & \phi_f &= 0.85 & \phi_v &= 0.80 \\ p_{min} &= \max(0.25\sqrt{f_{ck}}/f_y, 1.4/f_y) = 0.00467 \\ \text{계수 모멘트 } M_u &= 40.860 \text{ KN}\cdot\text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \\ \text{단면의 두께 } H &= 170.000 \text{ mm} & \text{단 면 폭 } B &= 1000.000 \text{ mm} \\ \text{유효 깊이 } D &= 130.000 \text{ mm} & \text{피복 두께 } D_c &= 40.000 \text{ mm} \end{aligned}$$

▷ 힘모멘트 검토

- 힘강도 검토

$$\begin{aligned} \text{사용철근량} &= D19 @ 150.00 \text{ mm} \quad (D_c = 40.00 \text{ mm}) \\ &= 1910.000 \text{ mm}^2 \quad \therefore P = A_s/(B \cdot D) = 0.01469 \end{aligned}$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 28.088 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.00880 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a/\beta_1 - D_{c_min}) / (a/\beta_1)$$

$0.005 \leq \epsilon_t$ 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\begin{aligned} \phi M_n &= \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 56476310.000 \text{ N}\cdot\text{mm} \\ &= 56.476 \text{ KN}\cdot\text{m} \geq M_u = 40.860 \text{ KN}\cdot\text{m} \dots \therefore \text{O.K} \end{aligned}$$

- 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 19.604 \text{ mm}$ 로 가정

$$A_s = M_u / \{\phi_f \cdot f_y \cdot (D - a/2)\} = 1333.096 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 19.604 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K}$$

$$P_{req} = [M_u / \{\phi_f \cdot f_y \cdot (D - a/2)\}] / (B \cdot D) = 0.01025 \Rightarrow 4/3 P_{req} = 0.01367$$

$$\therefore \text{필요철근량 } req.A_s = P_{req} \times (B \cdot D) = 1333.096 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K}$$

$$\text{철근비검토 : } P_{min} \leq P \dots \therefore \text{O.K}$$

▷ 사용성 검토 (균열 검토)

$$M_o = 19.700 \text{ KN}\cdot\text{m} \quad (\text{사용하중 모멘트})$$

$$n = E_s/E_c = 200000 / \{0.077 \text{ mc}^{1.5} * \sqrt[3]{(F_{ck} + \Delta f)}\} = 8$$

$$p = A_s/(B \cdot D) = 0.01469$$

$$\begin{aligned}
k &= -np + \sqrt{((np)^2 + 2np)} = 0.381 & j &= 0.873 \\
x &= k \cdot d = 49.576 \text{ mm} \\
f_c &= 2 \cdot M_o / (B \cdot x \cdot (D - x/3)) = 7.004 \text{ MPa} \\
f_s &= M_o / (A_s \cdot (D - x/3)) = 90.894 \text{ MPa} \\
f_{st} &= f_s \cdot (H - D_{c_min} - x) / (D - x) = 90.894 \text{ MPa} \\
\text{최외단철근 소요중심간격} \\
s &= \text{Min} [375 \cdot (210/f_{st}) - 2.5C_c, 300 \cdot (210/f_{st})] = 693.12 \text{ mm} \\
&\dots \text{여기서 } C_c = d_{c_min} - \text{주철근 직경}/2 = 30.50 \text{ mm} \\
\text{최외단철근 평균배근간격} &= 150.00 \text{ mm} \leq 693.12 \text{ mm} \dots \therefore \text{O.K}
\end{aligned}$$

2. 바닥판(캔틸레버부_DB18)

▷ 검토 조건

$$\begin{aligned}
f_{ck} &= 24.0 \text{ MPa} & f_y &= 300.0 \text{ MPa} & \lambda &= 1.00 \\
\beta_1 &= 0.850 & \phi_f &= 0.85 & \phi_v &= 0.80 \\
p_{min} &= \max(0.25\sqrt{f_{ck}}/f_y, 1.4/f_y) = 0.00467 \\
\text{계수 모멘트 } M_u &= 36.560 \text{ KN}\cdot\text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \\
\text{단면의 두께 } H &= 170.000 \text{ mm} & \text{단 면 폭 } B &= 1000.000 \text{ mm} \\
\text{유효 깊이 } D &= 130.000 \text{ mm} & \text{피 복 두께 } D_c &= 40.000 \text{ mm}
\end{aligned}$$

▷ 휨모멘트 검토

- 휨강도 검토

$$\begin{aligned}
\text{사용철근량} &= D19 @ 150.00 \text{ mm} \quad (D_c = 40.00 \text{ mm}) \\
&= 1910.000 \text{ mm}^2 \quad \therefore P = A_s/(B \cdot D) = 0.01469
\end{aligned}$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 28.088 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.00880 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a/\beta_1 - D_{c_min}) / (a/\beta_1)$$

$0.005 \leq \epsilon_t$ 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\begin{aligned}
\phi M_n &= \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 56476310.000 \text{ N}\cdot\text{mm} \\
&= 56.476 \text{ KN}\cdot\text{m} \geq M_u = 36.560 \text{ KN}\cdot\text{m} \dots \therefore \text{O.K}
\end{aligned}$$

- 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 17.380 \text{ mm}$ 로 가정

$$A_s = M_u / \{\phi_f \cdot f_y \cdot (D - a/2)\} = 1181.871 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 17.380 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K}$$

$$\text{Preq} = [M_u / \{\phi_f \cdot f_y \cdot (D - a/2)\}] / (B \cdot D) = 0.00909 \Rightarrow 4/3 \text{ Preq} = 0.01212$$

$$\therefore \text{필요철근량 req. } A_s = \text{Preq} \times (B \cdot D) = 1181.871 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K}$$

철근비검토 : $P_{min} \leq P$ $\therefore$ O.K

▷ 사용성 검토 (균열 검토)

$M_o = 28.120 \text{ KN}\cdot\text{m}$ (사용하중 모멘트)

$n = E_s/E_c = 200000 / \{0.077 \text{ mc}^{1.5} * \sqrt[3]{(F_{ck} + \Delta f)}\} = 8$

$p = A_s/(B \cdot D) = 0.01469$

$k = -np + \sqrt{(np)^2 + 2np} = 0.381$ $j = 0.873$

$x = k \cdot d = 49.576 \text{ mm}$

$f_c = 2 \cdot M_o / (B \cdot x \cdot (D - x/3)) = 9.997 \text{ MPa}$

$f_s = M_o / (A_s \cdot (D - x/3)) = 129.743 \text{ MPa}$

$f_{st} = f_s \cdot (H - D_{c_min} - x) / (D - x) = 129.743 \text{ MPa}$

최외단철근 소요중심간격

$s = \text{Min} [375 \cdot (210/f_{st}) - 2.5C_c , 300 \cdot (210/f_{st})] = 485.58 \text{ mm}$

...여기서.. $C_c = d_{c_min} - \text{주철근 직경}/2 = 30.50 \text{ mm}$

최외단철근 평균배근간격 = $150.00 \text{ mm} \leq 485.58 \text{ mm}$ $\therefore$ O.K